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Digital Object Identifier (DOI):
10.1080/19439342.2017.1363803

Published In:
Journal of Development Effectiveness

Increasing anti-malaria bednet take-up using information and distribution strategies: Evidence from a field trial in Senegal

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Acknowledgements

This work was supported by the Nuffield Foundation (Social Science Small Grants Scheme), Heriot-Watt University (SML Internal Research Grant), and the Carnegie Trust for the Universities of Scotland. We thank Mustapha Diop, Kyle McNabb, Francesca Tamma and Jasmine Wong for their assistance during fieldwork. Any remaining errors are our own. LeMay-Boucher wishes to thank the Kellogg Institute for International Studies at the University of Notre Dame and the School of Economics at the University of Queensland for research stays during which parts of this work was completed.

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Abstract

We evaluate the effects of different marketing and distribution techniques on the purchase of Long-Lasting Insecticide-Treated Nets (LL-ITN). Using an individually assigned quasi-randomized controlled trial in urban Senegal, we look at the impacts of different sale treatments. Receiving an offer to purchase an LL-ITN with a voucher valid for 7 days increases purchases by 23 percentage points, compared to an on-the-spot sale offer. We find suggestive evidence that providing information is not significantly correlated to the demand for LL-ITNs, but appears to be for individuals who have never attended school and have poor knowledge of malaria.

Highlights

- We evaluate the effects of different marketing and distribution techniques on the effective purchase of Long-Lasting Insecticide-Treated Nets (LL-ITN)
- We find that receiving a 7-day voucher significantly increases purchases by 23 percentage points, compared to an on-the-spot sale offer
- Randomization should be preferred to alternation in the allocation of treatments. Alternation can induce discretion from enumerators. This can lead to discrepancies between the actual allocation and the targeted one. It can also cause imbalances across samples.

Keywords: Malaria, Senegal, Randomized experiment, Bednets, Distribution campaign

JEL Codes: C93, I12, I15

1. Introduction

The use of Long-Lasting Insecticide-Treated Nets (LL-ITNs) has been shown to have a crucial impact in reducing the incidence of malaria and mortality of vulnerable groups such as children and pregnant women (Lengler, 2004). As such LL-ITNs is considered the most important malaria control tool by the Roll Back Malaria Partnership. Compared to just 3% in 2004, almost half of the at-risk population in Africa (49%) had access to an LL-ITN in 2013 (WHO, 2014). Because the use of ITNs has important spillover effects through the reduction of the mosquito population (Gimnig et al., 2003), there is an important opportunity for universal coverage. A malaria-free environment has positive effects on, for example, economic growth, development, school attainment and literacy (Gallup and Sachs, 2001; Bhattacharyya, 2009; Lucas, 2010; Barofsky et al., 2015). However, the target of universal access is far from being achieved and the level of use of such preventive tools remains low in countries with endemic malaria.[1] As pointed out by household surveys, the vast majority of people who have an ITN do actually use it (WHO, 2014), particularly during those seasons where the probability of infection is highest. The crucial issue seems therefore effective access to, availability of and demand for bednets.

An ongoing debate amongst health researchers and program directors regarding LL-ITN distribution frameworks considers whether it is it preferable to propose free distribution or to opt for some form of cost-sharing (see Sexton, 2011, for a review). This issue has notably been addressed by Cohen and Dupas (2010) in a randomized experiment on pregnant women in Kenya where it is found that the demand for ITNs is highly price sensitive and cost-sharing is not more cost-effective, in terms of child mortality, than free distribution. However, this is not the focus of our analysis. Our study constitutes an attempt to empirically evaluate the effects of different marketing and distribution techniques on the effective purchase of LL-ITN in a context where they are sold at a constant subsidized price to the general population.

Different countries have adopted various policies to promote LL-ITN coverage. These include free distribution to targeted populations (via, for example, antenatal clinics), both free and cost-sharing distribution during mass campaigns and selling LL-ITNs at a subsidized price at various specialized places such as pharmacies. 14 countries in Africa sell LL-ITNs at a subsidized price (WHO, 2014). In our area of interest, Thies in Senegal, the last distribution campaign of LL-ITNs was organized in 2009 and was characterized by cost-sharing. The campaign involved a door-to-door strategy to deliver a voucher for a subsidized LL-ITN, redeemable at a specific distribution point (health facility). Since 2009, general access to LL-ITNs has been available in private-run pharmacies at higher prices (around USD10) compared to the subsidized ones (USD3-6). By 2011, only 53% of the Senegalese population had access to an LL-ITN [2]. Given this relatively low figure, our paper attempts to see whether, in addition to having the LL-ITNs available at a fixed point, an on-the-spot door-to-door sale would improve take-up. The interest in comparing these two strategies lies with the different economic incentives and constraints faced by households. An on-the-spot door-to-door sale could be successful under the assumption that people are not cash constrained, but that they might have limited attention ('scarcity of attention') to the necessity of buying a bednet. Drawing their attention to such a need brings it to the 'top of mind' (Shah et al., 2012; Datta and Mullainathan, 2014). Conversely, a household aware of the need to buy an LL-ITN may face cash constraints. In this case, a voucher allowing some flexibility over the purchase date of the net could relax these constraints and increase the incentive to buy. Our study is the first to shed light on the relative effectiveness of different distribution strategies and to investigate the underlying mechanisms.

We thus offered subsidized LL-ITNs, at a price similar to the one set during the last national distribution campaign, for a limited period of time. The offer was addressed to the general population with no particular target in mind (i.e. not just vulnerable groups such as pregnant women or children). The study uses two treatments assigned through quasi-randomization (achieved through alternation). For the first, we quantitatively measure the impact of the distribution strategy on effective LL-ITN take-up. This treatment has two arms: first, we distribute door-to-door vouchers for the purchase of an LL-ITN, redeemable at a specific gathering points for seven days. This treatment arm mimics the government distribution campaign. Second through a door-to-door campaign we propose, at the same price as that of the voucher, an on-the-spot purchase of an LL-ITN. By comparing the effect of these two arms, we can assess if a larger uptake could be achieved by selling on-the-spot or with a redeemable voucher.

The second treatment, orthogonal to the latter, is related to information and assesses the role of knowledge of malaria and its prevention on the effective purchase of LL-ITNs. Studying the demand for subsidized bednets on the overall population is relevant if we consider that people buying bednets at subsidized prices are likely to buy other bednets in the future, at even higher prices (Dupas, 2014). We are able to estimate the heterogeneous effects our treatments had on relevant household characteristics at the baseline. In particular, we investigate: 1) the effectiveness of the voucher for different levels of income; 2) the effect of the information session at different levels of education and different levels of prior knowledge on malaria; 3) whether households with particularly vulnerable members (pregnant women or children under the age of five) are more susceptible of purchasing a LL-ITN following our two treatments and 4) if households who do not own a LL-ITN are more likely to react to our treatments. Our study focuses only on uptake, as we do not observe actual use of the LL-ITN once purchased.

The following two sections describe the Senegalese context and the methods we use (sampling and data). A further section covers in details our results and is followed by a discussion. The final section concludes by summarizing the results and offering a note on the relevance of our findings in a broader research context.

1.1 The Senegalese context

Malaria is an endemic disease throughout Senegal, with the entire population considered at risk. However, due to public intervention, significant improvements have been seen in the last 10 years. The share of outpatient visits resulting from malaria fell from 36% (clinically diagnosed and parasitological tested) in 2001 to 6% in 2008. About 7% of all deaths in children under five were attributed to malaria in 2008, compared to 30% in 2001 (President's Malaria Initiative; Senegal Malaria Operational Plan FY 2013). Significant progress has been made with regards the presence and use of ITNs by households, particularly the most vulnerable ones, thanks to large-scale distribution campaigns which will be described below in detail. At the national level, the share of households declaring that they owned at least one ITN increased from 45% in 2005 to 63% in 2010 (ANSD, 2012). Similarly, bednet availability has recently improved across Africa (Sexton, 2011; de Savigny et al., 2012).

In Senegal, the untargeted sale of subsidized LL-ITNs is one of the active strategies of the National Malaria Control Program's (NMCP) Strategic Plan 2011-2015. As suggested by WHO, this type of more routine 'keep-up' intervention should complement the occasional 'catch-up' mass distribution of free nets campaigns (WHO 2012). In the Senegalese context it is relevant to point out that distributional campaigns usually implemented some cost-sharing. At the time of our survey, there was neither a public campaign running nor was there a supply of subsidized bednets in Thies. To confirm this, we visited a number of health posts, health centers and hospitals in Thies during our pilot survey, in order to check their availability. This confirmed that no bednets were available at subsidized prices for the vulnerable population (pregnant women and children younger than five), nor for the population at large. LL-ITNs were available at privately run pharmacies at prices ranging from 5000 to 6000 FCFA (USD10-12), whilst non-impregnated bednets were also available on the market at 1500 to 3000 FCFA (USD3-6).

The NMCP is targeting a 75% reduction in malaria-related mortality (with respect to the baseline year of 2010) alongside 80% LL-ITN coverage of the general population by 2015 (Senegal Malaria

Operational Plan, FY2013). To fulfill such objectives, a number of LL-ITN distribution campaigns were undertaken, via several different approaches: (i) periodic mass distribution, (ii) targeted subsidized LL-ITNs for vulnerable groups (pregnant women and children), (iii) untargeted subsidized distributions (through health facilities and community-based organizations). By 2013, more than three million LL-ITNs had been sold or delivered to Senegalese households (WHO, 2014).[2] The campaigns involved a door-to-door strategy that delivered a voucher for a subsidized LL-ITN redeemable at certain distribution points. The usual subsidized price was 1000 FCFA (USD2). The last campaign also included a series of communication interventions to advertise the campaign and to increase awareness of the importance of using bednets (Thwing et al., 2011).

Health care in Thiès is organized according to a tiered system consisting of health huts (staffed by community health workers), health posts (staffed by nurses and certified midwives), and health centers or hospitals (staffed by medical doctors, nurses, and certified midwives). The health district of Thies has one regional public hospital and one privately run mission hospital. Data for this region shows that the ratio of inhabitants to health centers is seven times greater than WHO standards, while the ratio of inhabitants to health posts is in line with international norms (ANSD, 2008).. In Thiès, there is a large number of health huts, posts and pharmacies. These infrastructures are evenly distributed geographically and allow for health seeking behavior among households. Episodes of sickness, in particular malaria, are generally treated at health centers or hospitals. Furthermore, public campaigns currently allow people to test for malaria at subsidized costs (around USD1).

2. Methods

2.1 Survey area, sampling and data

Data were collected in May and June 2012 in the city of Thies, the third most important city in Senegal with a population of about 263,500 inhabitants (2007 census) covering an overall area of approximately 20km square. The city is organized into nine neighborhoods. Our initial sample consists of 527 households which were selected across the whole territory of the city.[3] In order to obtain a representative sample of the population, the number of households selected in each neighborhood was proportional to the corresponding population. Since an official list of households was not available in public records, households in each neighborhood were selected with a pseudo-random selection technique, which followed Afrobarometer's survey guidelines. Using an official map of the city, we chose a random set of streets in each neighborhood. A sample of households was selected on each chosen street. Prior to the beginning of the baseline survey, all neighborhoods were visited and the list of all streets with private houses was updated. Streets hosting a majority of economic activities (like markets, shops and public buildings), as opposed to housing, were excluded from the list. Enumerators were instructed to enter and survey every fifth house on the left on each chosen street (making our selection process pseudo-random). In case the selected door was unoccupied, the enumerator had to select the next house. Where settlers were absent, or when neither the head of household nor the spouse was available, a second visit was scheduled. We employed nine local, independent and qualified enumerators. All had previous experience with surveys and field work and undertook a two-day training session given by the authors. Special sessions were dedicated to translation in the local language (Wolof) and to test enumerators' understanding. Enumerators were also followed by a local experienced supervisor during the early stage of their work.

As unit of analysis, the household, we consider nuclear units as composed by spouses, their children and other members of the family who economically depend of the head of the nuclear unit (Van de Walle and Gaye, 2005). Enumerators were instructed to randomly select among nuclear units when entering a house inhabited by an extended family. The reason of this choice lies in the fact that, most of the time, decisions on health behaviors are made at the nuclear unit. In our context, and this can safely be extended to the broader national level, the husband is generally considered to be the breadwinner and the head of the nuclear unit and as such is expected to take the most relevant economic decisions for the members of his unit (from now on called 'household'). For 49% of the households surveyed the respondents was the head.[4] In the remaining cases the respondent was most often the spouse or another adult member of the household. We investigate below the possible consequences of this. We compensated the respondents for the time spent answering the questionnaire with a phone recharge of 1000 FCFA (USD2), which was directly provided by the enumerator before leaving the house (a small minority of households did not own any mobile phone).

Our baseline survey aimed to obtain information on each household member's level of education, health problems (sickness and chronic diseases) and related expenditures, particularly concerning malaria. Since public campaigns about malaria specifically target pregnant woman and children under five years of age, we made sure to identify such households in our analysis. Household income represents the sum[5] of all sources of monthly income (labour income or wage, rent and received transfers) across all active members of the household. Due to the sensitivity of such questions and the reticence to provide exact amounts, answers were in most cases collected by offering ten income intervals. We then categorized this variable into quintiles. We computed a synthetic measure of durable goods or assets owned by the households as a proxy for wealth. This is simply the sum of a list of items comprising, among others, a series of kitchen and home appliances, mobile phone, bicycle, motorcycle, car, sewing machine, different pieces of furniture, etc. Additionally, we identified whether the household owned their dwelling unit. We tested, at the baseline, the knowledge of basic information on malaria and public bednet distribution policies through a set of true-false questions. We used five questions to test the level of knowledge on malaria.[6] A second set of questions were aimed at understanding the extent to which people were aware of past public bednet distribution campaigns and their features.[7] Concerning malaria prevention, we asked people to list all known methods. We also investigated what symptoms are associated with malaria, the knowledge of LL-ITNs and their market price. We collected information on the ownership, type, number, date and source of obtainment of any bednets in the house and the reason why one does not have one. For those declaring that at least one bednet was owned, we asked if it was used the previous night and by which member of the household.[8]

2.2 Experimental design and empirical approach

Treatments were assigned at the household level through 'quasi-randomization' (achieved through alternation), after stratifying at the level of neighbourhood. Around 43% of the sample received our short information session on malaria during the baseline survey, whilst the remainder did not. After testing prior knowledge of malaria causes, means of transmission, prevention and use of bednets, enumerators presented a short informational module of around 7 minutes. This provided information on the following eight points[9]: 1) How malaria can be contracted; 2) Incidence of malaria in Senegal and its particular impact on mortality and sickness for pregnant women and children under 9 years old; 3) Average size of health expenses due to malaria in the city of Thies (based on the data collected during our pilot survey); 4) Benefits from the use of LL-ITNs in terms of lower incidence of malaria, lower expenditure and consequent possible savings from its use (also based on the data collected in Thies during our pilot survey); 5) Importance of having a bednet for every bed and its use throughout the year; 6) Availability of bednets in Thies and where they can be purchased (namely at pharmacies at full price: around 5000 FCFA - USD10); 7) Availability of subsidized bednets during public campaigns and discussion on the timing of such campaigns; 8) How to effectively use LL-ITNs. Our two treatments were set up to mimic ones that could be deployed on a large scale such as a national campaign. As such the information needed to be uniformly conveyed in a relatively short period of time to a large audience. Its content (with the addition of point 3 listed above in this paragraph) is similar to different posters on the topic that can be found in various pharmacy or health clinics in the region. Our information treatment was thus not designed to be tailored to each participant with a refined curriculum that would engage with each participant's experience with malaria. We understand that such a campaign is likely to be more effective but takes significantly more time and is practically difficult to implement on a large scale.

Independently from the information treatment, households were assigned to the LL-ITN sale treatment. About half of the sample (53%) was proposed the on-the-spot sale of one LL-ITN at the subsidized price of 1000 FCFA (USD2). The validity of the offer was immediate and lasted around 15 minutes (the average time it took to complete the questionnaire at that stage). Respondents were allowed to discuss the purchase with anyone if they wished so. The second half of the sample (47%) received a voucher valid for 7 days, during which the respondent could contact the enumerator to receive one LL-ITN at the subsidized price of 1000 FCFA (USD2). Once ordered by phone, the LL-ITN was delivered at an agreed meeting point by the enumerator. Each enumerator had one easy-to-find point of delivery in each neighborhood.

For the first treatment (information), we asked our enumerators to alternate one treated household with another non-treated while they were doing the baseline survey. The completed questionnaires were then returned. For this treatment, we have unequal size of groups between the info (211 households, 43%) and no-info (279 households, 57%) arms. We initially targeted a proportion of around 50% of our sample to receive the info treatment but 37 questionnaires filled by one enumerator were discarded because we had doubts about the way he presented the information (we thought it was biased and non-neutral). These questionnaires could not be replaced due to time and budget restrictions. A discussion of the impact of such data loss on the external validity of the study is presented in section 4. Beyond that, we observe a 3% deviation (31 questionnaires) from the 50-50 targeted allocation. Successive sequences of odd groups of questionnaires may explain an important part of this imbalance (e.g. succession of days in which an enumerator complete 5 questionnaires with 3 treated and 2 non-treated). Given that the treatment assignment was done at the discretion of the enumerators we cannot rule out that some form of deviation from alternation took place or that some form of selection may have happen for a small number of households. However, we have no anecdotal evidence from the field to that effect. The results on the information treatment are thus interpreted with caution and as correlational.

The second treatment (sale: voucher/on-the-spot) was assigned in a pre-randomized fashion. We would usually issue one enumerator a set of around 15 questionnaires (with small variations around that number) related to a neighbourhood. The allocation of treatment was communicated to the enumerators by assigning a label on each (for example: ‘voucher treatment’ or ‘on-the-spot sale treatment’). We have a smaller difference between the voucher (229 households, 47%) and on-the-spot sale (261 households, 53%). We know that for a very small number of questionnaires (only 2) that instruction was not followed. The most likely reason for the remaining imbalance lays in the fact that the assignment of label was made independently from one group of 15 questionnaires to the other: hence it is possible that we have ended up with 7 'voucher treatment' and 8 'on-the-spot treatment' in a succession of different groups of 15 questionnaires. The unsystematic nature of such deviation does not represent a threat to our identification strategy and to the causal interpretation of the effects of the sale treatment. It is important to add that our treatments were stratified by neighbourhood (i.e. the proportion of households assigned to each treatment group within a neighbourhood is equal to the total proportion of households in each group). Figure 1 shows the CONSORT flow diagram incorporating these elements.

[Insert Figure 1 here]

Our baseline survey is followed by our first treatment (information session on malaria; control receives no information). Once that first phase is completed we offer our sale treatment (either the on-the-spot sale or the voucher valid for seven days). All the households who receive our first treatment were treated with either the on-the-spot sale (229 households) or the voucher valid for seven days (261 households). For all households initially selected we could thus determine if they bought an LL-ITN on the spot or within the seven day period and as such there is no attrition. We do not have an endline survey, nor did we need one for the following reasons: 1) the baseline and the two treatments were completed within two months; and 2) our fieldwork did not intend to look at LL-ITNs use over time.

To assess the impact of the sale and information treatments on the effective demand for LL-ITNs, we estimate the following model through a linear probability model (LPM) by Ordinary Least Squares (OLS):

$$B_i = X_i' \beta + \alpha \, Info_i + \delta \, Voucher_i + \varepsilon_i$$

In the equation, *B* is a dummy variable that takes the value one when the household bought an LL-ITN and the value zero otherwise. *Info* is a dummy variable that equals one when the household was provided with information on malaria. *Voucher* is a dummy variable that equals one when the household was given a voucher and equals zero if offered to buy a LL-ITN on the spot. *X* is a vector of covariates which contains respondents' characteristics (gender, education, age, marital status), two indicators of household wealth, presence of household members who would benefit from free bednets in case of campaign (namely targeted groups: pregnant women or children under the age of five), household size, ownership of bednets (any type: whether insecticide-treated or not), experience of malaria cases in the last year and our two knowledge scores. Households are indexed with the subscript *i*. The coefficients of interest are α and δ, which measure the effects of receiving information on malaria and of receiving a voucher on the respective probability of buying an LL-ITN. As stated above, we faced minor problems related to partial compliance in the allocation of the sale treatment. This was the case for very small fraction of the sample: 2 questionnaires out of 490 or 0.04% of the total number of questionnaires. This means that estimating the Intention to Treat Effect (ITT) does not offer different results from the specification above.

We are also interested in testing four relevant hypothesis on the heterogeneous effects of the impacts coming from our treatments. First we want to know whether households with targeted members (pregnant women and children under the age of five) are more susceptible of purchasing a LL-ITN following our two treatments. Households with members belonging to these vulnerable groups may respond more positively to our information and voucher treatments by seeking to provide a LL-ITN for them. Second, we look at the effectiveness of the voucher for different levels of income. Our intuition is that the voucher could have a greater impact on the uptake for poorer households. It could give additional time to cash-constrained households to find the necessary funds for the purchase. Third, we want to check if the information treatment has a greater impact on respondents with low levels of education or low level of prior knowledge on malaria. The intuition being that the information we offer is likely to have less impact on respondents who already know a significant part of it. This may be the case for highly educated respondents and those who scored highly in our knowledge test about malaria. Finally, we want to see if households who do not already own a LL-ITN are more likely to react to our treatments. These households may ignore the benefit of owning a LL-ITN and our treatment may have a greater impact on them. Households who already own one have a better idea of their benefits and may be inclined to buy another one, either through our voucher or information session acting as a reminder. Conversely, such benefits may not be obvious to these owners and our treatment of little impact on the decision to purchase. The tests of treatments heterogeneities is based on the inclusion of the interactions of relevant treatments and the specific variables measured at the baseline in the model shown above.

Sample balance across treatments is tested by comparing sample means of our variables measured at the baseline across different treatment samples. We compute adjusted differences between treatment and control groups, obtained from a regression of the baseline variable on the treatment variable and neighbourhood fixed effects, i.e. stratification variables. P-values of the T-test of the treatment coefficient are computed and shown. It is not uncommon for random assignment of treatments in small samples like ours to be unbalanced. The presence of observed differences between treated and non-treated groups is taken into account during estimation. The first approach used for this is to systematically include all relevant controls, in the set of covariates in our estimation models. The second approach used is to re-weight the sample using entropy balancing so that the first three moments computed by treated and non-treated groups are equalized (Hainmueller and Xu, 2013).

3. Results

3.1 Descriptive statistics

Table 1 presents the allocation of the sample across treatments and the proportion of households who bought an LL-ITN within subsamples according to treatment status. Following the treatments, 44 % of households purchased an LL-ITN. About 56% of household that received a voucher redeemed it within seven days and bought an LL-ITN at a subsidized price, compared to only 34% of households exposed to the on-the-spot sale. The difference of 22 percentage points between these two proportions is significant ($p < 0.001$). Regarding the information treatment, 46% of households provided with the information bought an LL-ITN, slightly higher than the proportion of households (43%) who bought the LL-ITN with no additional information on malaria. In this case however, the difference is not statistically significant ($p=0.151$).

[Insert Table 1 here]

Table 2 reports, for the whole sample of 490 respondents, the mean and standard deviation for all variables which are relevant in the analysis. A majority of our respondents are female and live in a couple. 49% of our respondents are head of household of which 80% are male. These individuals represent 39% of our overall sample. In the next section we look at the potential impact of surveying non-head of households on the purchase of LL-ITNs.

The average household size is six and around 45% of respondents attended secondary school or higher levels of education (successfully completed at least six years of schooling). 58% of the households surveyed are susceptible of being targeted households in a distribution campaign. That is to say they have at least one member who is either a pregnant woman or a child under five years of age. Around three quarters of our households own the dwelling unit where they live. Regarding malaria, we observed that 46% of sampled households had experienced at least one episode of malaria during the year prior to the survey.

[Insert Table 2 here]

The average score out of 5 for the variable 'Malaria knowledge score' is 3.6 (median is 4).[10] The mean of the variable 'Anti-Malaria campaigns knowledge score' (out of 3) is 2.1 and half of our sample correctly answered all questions; 13% correctly answered none. There is only a weak correlation (0.015) between the two knowledge scores. Across all levels of malaria knowledge score, a large majority of respondents are fully aware of what public bednet distribution campaigns involve, in terms of distribution sites, targeted groups (pregnant women and children under the age of five) and subsidized prices. Concerning malaria prevention, 93% of interviewees mention the use of bednets, 42% the employment of insecticide sprays and 59% the avoidance of stagnant water nearby the house. The most cited symptoms of malaria are high temperature (86%), nausea (60%) and headache (42%). Only 2% of respondents could not name any (correct) malaria symptom. These statistics convey a relatively high degree of awareness, means of prevention and identification of malaria. In spite of the awareness of the importance of the use of bednets, only 28% of respondents declared that they knew what a LL-ITN was; only 12% knew the correct retail price of the product in private pharmacies. More than half of sampled household respondents (59%) claimed to have at least one bednet at home. The most common reasons for not having bednets are negligence (47%), lack of means (19%) and use of other methods (12%). Conditional on owning at least one bednet, the average number of bednets per household is about 2.4, whereas if we consider the whole sample, the number decreases to 1.4. Considering an average household size of 6 members, it is entirely possible that the number of bednets owned is insufficient to cover the entire sampled population, even after considering the possibility that several members of the household, such as children or couples, share the same bednet. Among households owning a bednet, only 17% had impregnated ones.[11] Moreover, although respondents claimed to have owned bednets for over 2 years (on average), only 10% of owners had re-impregnated them within the last year. 41% of bednet owners paid to acquire them (the average price paid is about 2000FCFA, around USD4), whereas the remaining 59% said that bednets were obtained for free at health posts or centers, hospitals, or were distributed by the neighborhood chief or some NGOs during previous distribution campaigns. In the sample, 18% (22%) of pregnant women (children younger than five) responded that they slept under a LL-ITN the night preceding the interview. This number is slightly lower than the 22% (28%) who declared that pregnant women (children) slept under ITNs in the previous 12 months according to the large scale DHS (2010-12).

Table 2 also shows the tests for random assignment of treatments, through the comparison of adjusted means. Our quasi-randomization with respect to the sale treatment (voucher) appears to be satisfactory. Some significant differences are observed between households who were given the information treatment and those who were not. These are related to attributes of the respondent:

namely is gender, whether he/she is the head, education levels and the malaria knowledge score. The mean comparison tests also suggest significant differences with respect to household size. Additional balance tests, not shown, on all our nine neighborhoods and ten enumerator dummies, indicate that almost all (18 out of 19) of these controls are balanced with respect to our two treatment assignments.

3.2 Results

Table 3 displays the results of the LPM, estimated by OLS.[12] The different columns present the regression coefficients of our treatment variables when we include baseline controls and neighborhood fixed effects. The first two columns display the results for the unbalanced sample and the last two the balanced one.[13] We find that providing a voucher to buy an LL-ITN within seven days has a significant and positive effect on the probability of purchase, compared to an on-the-spot sale offer. The magnitude of the effect is between 22 and 24 percentage points. This corresponds to a 60% to 65.5% increase in take-up rate with respect to the control group receiving on the spot sale and no information. We also find that providing information on malaria has, on average, no significant effect on the probability of buying an LL-ITN[14]. Controlling for treatments, households in the first income quintile buy on average 19% more than rich ones (the fifth quintile is the benchmark). The coefficient for the first quintile is lower than for quintile two, three and four but the difference is not statistically significant. The various levels of education included in the specification appear to play no significant role (the reference group being post-secondary education).

[Insert Table 3 here]

In table 4 we investigate whether the effects of the two treatments display any heterogeneity. We first look at a targeted subpopulation: households with a pregnant woman and/or with a child under five years old (columns 1 and 2). The difference of estimated treatment effects within this group is not significant both for voucher and information. In column 3 and 4, we find that the voucher had no differential effect depending on the gender of the respondent, neither alone, nor in combination with the marital status (i.e. living in a couple). In column 5, the heterogeneity of the voucher effect is estimated across income quintiles. We find no heterogeneous effects of the voucher treatment along the household income dimension.

[Insert Table 4 here]

Finally, we investigate the heterogeneity of the information effect across education groups (column 6) and baseline malaria knowledge scores (column 7). Receiving the information treatment session increases the probability of buying the LL-ITN by 34.5 percentage points for households where the respondent has no formal education, compared to those where the respondent has a high level of schooling (above secondary education). The result is significant at 5% confidence level. We also find that respondents with post-secondary level of education react to the information treatment by buying less (p-value=0.099). A positive and significant heterogeneous effect of the information treatment is found on respondents with low level of knowledge of malaria (+20 percentage points, significant at 10% level). In column 8, we find differential effects (+18.0 percentage points, significant at 5% level) of the informational treatment amongst households who do not own at least one bednet (any type: whether insecticide-treated or not). No effect is found for the voucher treatment for households who own already at least one bednet. Column 10 reports the results for the full model specification where all the interactions have been included. All previous results are confirmed except for the interactions between the informational treatment and both post-secondary education and low malaria score.

4. Discussion

The result on the informational treatment suggests that improving literacy on the prevention of malaria, on morbidity due to malaria or direct and indirect costs generated by an episode of malaria, has, on average, no significant effect on buying an LL-ITN. One interpretation is that the information session did not sufficiently increase the expected benefits of bednet usage to a level that outweighed the costs.[15] It is also possible that knowledge about malaria was, on average within our sample, sufficiently high to make this session ineffective. The quality of the delivery of this information could have played a role. However, we believe this to be unlikely, given that the session was short and well-rehearsed by our enumerators during our pilot. The coefficient on the variable "info" is not affected if we introduce enumerators fixed effects. We also ensured that the content of the information session was identical across households and included health and financial framing. Both health and financial-related consequences of malaria were described to households, as well as various means of prevention. Enumerators were trained to deliver the information module uniformly. They were instructed to go through the eight information items listed above in the same sequence and to provide the same set of facts and details.

The process of allocation of the information treatment may put the validity of our inference into question. First, the loss of 37 questionnaires in the information arm could influence the external validity of the study. These losses occurred in similar proportions in five out of nine neighbourhoods, representing a loss of data ranging from 9.5 to 15% across them. We find that the 37 households dropped from the sample are, on the whole, similar on average to the ones in the final study sample of 490. They differ for three variables out of the 18 used in our specifications in table 3: they are less likely to own the dwelling; more likely to belong to targeted groups during campaigns (presence of pregnant women or children under the age of five) and less knowledgeable about anti-malaria campaigns. Results are not shown but are available upon request. They are obtained by running a regression on a dummy which takes value 1 if a household was excluded from our sample (this applies to 37 households out of the 527 included for this estimation) and takes value 0 if it was not excluded. The controls consist of the 18 variables used in our models in table 3. Table 2 confirms that the allocation of both information and voucher treatments do not vary significantly along these three dimensions. Out of those three, low knowledge about anti-malaria campaigns is the only one significantly related to LL-ITN take-up (see table 3). However, it does not generate significant heterogeneous effects with both treatments (these interaction terms are not shown in table 4 but available upon request). Overall, these results seems to indicate that the data loss from the information treatment is unlikely to affect much the external validity of your findings. The study sample slightly underrepresents people with low level of knowledge about anti-malaria campaigns which positively predict take-up, although such dimension does not seem to significantly interact with the treatments. This implies that, if anything, the final take-up rate may be slightly underestimated.

Second, as discussed above, the assignment of the information treatment was done through alternation, allowing some discretion to the enumerators. Although we do not have direct evidence that deviations from the instruction given occurred, the two arms sample sizes differ from the target (43% information vs 57% no information, instead of 50-50). We also find some variables along which the two treatment arms appear imbalanced. In the impossibility to establish the extent to which deviations (if any) was systematically related to some enumerator or neighbourhood and as a robustness check, we repeat the analysis and cluster the standard errors at these levels in turn. Our results, available upon request, are not affected. Nevertheless, the reader should interpret the effects related to the information treatment as correlational.

It is notable that our tests, based on our actual sample sizes, could detect expected effect size at the design phase (of 10-15%) with power well above the threshold of 80%, which is widely considered as satisfactory. Thus, lack of power is not considered an issue.[16] The ineffective role of information on take-up is not specific to this study; it has also been observed in different contexts, notably related to the purchase of health insurance and financial technology (Bonan et al., 2017; Thornton et al., 2010; Cole et al., 2013). Our finding is also in line with that of other works which found that social marketing treatments, under the form of promotional messages, had no effect on bednet purchase in Kenya (Dupas, 2009).

The positive and significant effect on purchase obtained through the voucher shows the advantage in guaranteeing a subsidized price over a week. Households who use the voucher opt for a delayed purchase and do not need to have "cash-on-hand", an amount of money to be used immediately, to purchase the LL-ITN. Our results seem to indicate that the most important factor at play is the cash constraints that households face. This constraint on take-up is also highlighted elsewhere (Dupas, 2009 ; Holla and Kremer, 2009; Tarozzi et al., 2014). Another plausible explanation is that the respondent, who in 49% of cases was the head, needed to consult with their spouse or somebody else in the household in order to approve the purchase, which imposed a delay on the decision to purchase. As we mention earlier, men tend to have greater say over household purchases than women. If this mechanism is important we would expect that households in which a man was interviewed and presented the opportunity to purchase an LL-ITN would be relatively unaffected by the additional time to confer with other members. The man would be relatively able to make the decision unilaterally. However, given that the interaction terms of 1) respondent is male and 'voucher' and 2) respondent is male, 'voucher' and the respondent lives in couple are both not significant in table 4 (in columns 3, 4 and 10), this explanation may not be valid within our context. Furthermore, results from table 3 in columns 2 and 4 where the dummy 'the respondent is male' is not significant seem to confirm this or could indicate that potential differences in preferences towards bednets for men and women do not seem to play a significant role. The lack of systematic gender differences in the willingness to invest in anti-malaria bednets is also found in another study (Dupas, 2009)[17].

Heterogeneous effects displayed in table 4 show that households with targeted members (pregnant women and children under the age of five) seem no more susceptible of purchasing a LL-ITN following our two treatments than other households. This despite emphasizing the incidence of malaria in Senegal and its particular impact on mortality and sickness for these groups in our information treatment. Results in column 5 indicate no significant heterogenous impact across the four different income quintile included (the benchmark being income the richest quintile 5). To get a coefficient for each of the five quintile for the sample which received the voucher we compute the marginal effects, using post-regression contrast margins for the model in column 5 (Figure 2).

[Insert Figure 2 here]

Figure 2 shows that with 95% confidence interval the first income quintile is not statistically different from zero, while all the other are (results holds if we use a 90% confidence interval). This indicates that the households belonging to income quintiles two to five are more likely to buy a LL-ITN after receiving the voucher than when being treated with an on-the-spot sale. However, this is not the case for households in the poorest quintile who buy as much with both the voucher and on-the-spot sale.

Table 5 displays the rates of purchase per income quintile for both arms of the sale treatment. For the on-the-spot treatment, the share of households who purchased in the first income quintile (32%) is not significantly different to all other quintiles (at 5% level). As such, the poorest respondents do not appear comparatively cash constrained. If we compare the purchase rate for the voucher, respondents from the first quintile have the lowest rate. The first quintile is indeed the only quintile which shows no significant difference between the two arms of the treatment. The poorest do buy, if they can afford on the spot, and providing them with the flexibility of a 7-day voucher does not significantly change that rate. One reason could be that the poorest are not as cash-constrained as we imply. The mean household income for the first quintile is 49000 FCFA and a subsidized LL-ITN at 1000 FCFA represents only 2% of their monthly income. Instead, the poorest might have limited attention ('scarcity of attention') to the necessity of buying a bednet. Drawing their attention, with an on-the-spot sale, to such a need brings it to the 'top of mind'. If given a voucher, the poorest may have the cash at hands but decide to postpone the purchase for a few days. It is plausible that this then allows various other pressures and demands on their small income to take precedence. This may then divert their attention to other more pressing issues and expenses. Even if the LL-ITN stays salient this will take cash away from its purchase. This dynamic has also been found in different contexts (Shah et al., 2012; Datta and Mullainathan, 2014; Karlan et al., 2016). For the poorest, the strong incentives of a short-lived on-the-spot sale and the flexibility of the 7-day voucher lead to similar rate of purchase.

The descriptive statistics for both arms combined show that both income quintiles 1 and 5 have significantly lower rates of purchase than other middle quintiles (at a 10% level of significance). These differences, at the combined level, are partially explained by the fact that the poorest are less responsive to the voucher. Overall, the very poor are relatively more hampered in their access to LL-ITN, even when they are sold at such a low subsidized price. This should be stressed to governments and NGOs which organize distribution strategies that are based on cost sharing. For the households in the richest quintile who could afford to buy a LL-ITN from a pharmacy without the subsidy we offer, our treatment appear less effective and represent a weak incentive.

[Insert Table 5 here]

The positive heterogeneous effect from the information session we observe for respondents with no education is confirmed by figure 3. Based on model 6 of table 4, it shows the predictive margins for all interactions of the information treatment and the four education levels.

At the baseline, there are significant differences in our variable ‘malaria knowledge score’ across different levels of schooling. As intuition would suggest: respondents with no schooling tend to get lower scores than educated ones. This may partially explain why our information session has a positive and significant impact on the respondents with no schooling. Our information session also stressed direct and indirect costs of a malaria episode which was not covered in our five questions quiz used to construct the ‘Malaria knowledge score’. This type of financial information may have had a particular impact on the respondents who have never attended school. It is also possible that the fact that our information session was offered in a one-on-one environment could have been particularly suited to respondents who are unlikely to be able to read and to be reactive to different format of public campaign. There is also a significant positive heterogeneous effect from our information session for respondents who obtained a low malaria score (0-2) in our baseline knowledge test of five questions. Households who do not own a bednet (any type: whether insecticide-treated or not) previous to our treatments are more likely to react positively and significantly to the information treatment but not to the voucher.

[Insert Figure 3 here]

Our results highlight significant heterogeneous effects from the information session related to: lack of education and the use of bednet within the household and to low level of baseline knowledge on malaria. They suggest that information may be effective on those with no schooling, poor knowledge of malaria and those with no direct experience in the use of bednets. One can argue that these individuals are the ones who are likely to attribute a lesser value to the LL-ITN. According to our findings they can be influenced into buying an LL-ITN following our information treatment. These heterogeneous effects suggest that targeting the information treatment to these subgroups might represent a more efficient way of using limited advertisement or campaigning resources.

The use of alternation, instead of randomization, is more prone to enumerators' discretion in the allocation of treatments. This makes it more difficult to track any mistakes or incoherences. A key lesson from our work is that alternation, to be correctly monitored, requires more time and a closer supervision on the field.

5. Conclusion

This paper investigates the demand for Long Lasting Insecticide Treated Nets (LL-ITNs) in a region where malaria is endemic and malaria prevention weak. Our study presents suggestive evidence that the information session is not correlated with the demand for LL-ITNs. This result is not surprising if we consider some of the recent literature on the effect of information on the demand for health related products. However, we observed a positive association between information and respondents' low level of schooling, low knowledge about malaria and lack of direct experience in the use of LL-ITNs. This suggests that targeting households when giving information would be a more efficient way of increasing take-up. Both our descriptive statistics and our regression analysis indicate the importance of the role played by the voucher. Being given a 7-day voucher for purchase at a subsidized price increases the probability of LL-ITN purchase by 23 percentage points, on average, compared to an on-the-spot sale offer. This result may highlights the importance of cash constraints faced by many households across most income quintiles. Except for the very poorest households (1st quintile) who show similar rate of purchase for both the voucher and the on-the-spot sale.

We think that our results from Thies could also be relevant to other cities of similar size in Senegal: Mbour, Rufisque, Kaolack, Saint-Louis and Touba. The context of bednets distribution and the local healthcare infrastructures are somehow similar in these sites. Taken jointly these medium size cities account for around a fifth of Senegal's population. Whether we can extend the relevance of our results to poorer rural regions of Senegal is difficult to say: healthcare infrastructure are less developed and our different sale treatments would have to be adapted with more important reduction from the usual retail price. Our treatments would also need to be adjusted for the richer city of Dakar where bednets are relatively less expensive and more widely and consistently available in various shops/pharmacies. This is why we are cautious about extending our results to the whole of Senegal.

[1] Out of 584,000 estimated malaria deaths, 90% occurred in Africa (WHO 2014).

[2] In some cases, LL-ITNs distribution was bundled with the delivery of vitamin A supplementation, deworming and/or mebendazole to targeted households.

[3] Our study was designed to minimize any spillover effect by dispersing as much as possible the different households selected. By using the whole territory of Thies we managed to survey on average 35 heads of household per km square. According to estimates from the city of Thies the population density of the area is about 5900 inhabitants/km^2. This makes spillover effects unlikely, however we cannot completely rule them out. Our neighbourhood fixed effects should control (at least partially) for such possible local effects. It is important to mention that we have no GIS data localising each of our households and as such it is impossible for us to construct a variable measuring the number of households treated within a given radius of a given household. However, measuring spillover effects is a difficult task in itself. If we were to generate a model where the outcome of each head depends linearly on her own characteristics and on the mean outcome of her reference group (or neighbours' actions or take-up within a given radius) we would face the 'reflection problem' (Manski, 1993). This implies that we would be unable to distinguish between 1) contextual effects or more generally spillover effects, from 2) correlated effects: individuals in the same reference group tend to behave similarly simply because they can be similar with respect to certain characteristics or face a common environment. In other words, if we were observing that people assigned to the 'voucher' arm tend to buy more when living in clusters with high shares of people who bought an LL-ITN assigned to the on-the-spot arm, this would not necessarily be due to spillover effects. Our study design was not meant to rigorously assess these issues.

[4] Different reasons can explain why we could only have half the heads answering the questionnaire. In many cases they do not live on the dwelling visited for work related reasons and only pay regular/irregular visits to the household. A limited number of heads did not have the time to answer and delegated either their spouse or another adult. We did not meet anybody who refused to take part in the survey.

[5] An alternative to this addition would be to use an index generated from principal component analysis. If we use the first principal component instead of the sum, the results presented in the paper would remain similar.

[6] We asked respondents to state whether the following statements were true or false (the share of correct answers is given in parenthesis): 1. Malaria is a contagious disease (30) (false); 2. Mosquitoes contaminate food (68) (false); 3. Mosquitoes transmit the disease in daylight (73) (false); 4. Mosquitoes reproduce themselves in stagnant water sites (98) (true); 5. Mosquitoes transmit malaria by just biting the skin (91) (true).

[7] We asked to state whether the following statements were true or false (the share of correct answers is given in parenthesis): During a public bednet distribution campaign: 1. If I go to the health centre I can get free bednets for children less than 5 (65) (true); 2. Pregnant women can get free bednets at health posts and health centres (69) (true); 3. Everybody can get bednets at subsidized prices at health centres (76) (true).

[8] We also collected data which allowed us to elicit discount rate and risk parameters. These parameters were used as control variables in a previous version of this paper and they did not have any effect on take-up of bednets.

[9] A detailed description of the content of the information session is provided in Appendix 1.

[10] To investigate heterogeneity along the knowledge of malaria in the regression analysis which follows, the malaria knowledge score has been split into two categories, low (0-2) and high (3-5), whose shares in the sample are 14.5 and 85.5%, respectively. There are no significant differences in these shares across the sub-samples for our two treatments.

[11] It is likely that the number of ITNs or LL-ITNs is underestimated due to the lack of awareness of the properties of the product.

[12] The size and significance level of marginal effects for the treatment dummies using logit and probit are very similar from those obtained with OLS for our different models. The full set of results is available upon request.

[13] The differences we observe between the two sets are small and attributable to a satisfactory random assignment for the voucher treatment and only some significant differences for the information treatment.

[14] We do not find a significant effect from the interaction of the two treatments in the various models we display. Adding this interaction term does not change the magnitude of the treatment coefficients estimated in Table 3.

[15] Alternatively, because of liquidity constraints, people might not have been able to pay either on the spot or within a week for a LL-ITN, despite the expected high benefits.

[16] If we fix the level of power at 80% and use a 10% alpha, our design could detect the following effect sizes: i) 0.095 for the voucher arm based on the actual uptake rate for the on-the-spot arm of 0.34 and ii) 0.097 for the info arm based on the actual rate of uptake for the no info arm of 0.43.

[17] It is possible that the effect of the voucher comes from a combination of time to think about the decision to buy as well as a 'deadline effect'. However, we do not have data on the timing of the purchase relative to the seven-day window and thus cannot investigate any 'deadline effect'. It is also possible that over the seven days covered by the voucher, individuals collected additional information on the LL-ITNs. We did not ask such question at the time of purchased. However, we think that being exposed to additional information would not significantly push individuals to buy. If this was the case, we would expect the information treatment (which provided information on prices and many other details on LL-ITNs) to have a significant effect on the probability to purchase the LL-ITNs for the sample of individuals who received the seven-day voucher. This was not the case. Finally, we cannot discard entirely that there is a small chance that individuals with the on-the-spot sale offer believed that they would be able to still buy an LL-ITN later at the subsidized prize. However, these believes were unlikely to be based on a foreseeable possibility to purchase at a subsidized price through a publicly funded distribution campaign. At the time of our fieldwork, no LL-ITNs distribution campaign was scheduled or announced. Such distribution campaigns represent, to our knowledge, the only opportunity for locals to buy at a subsidized price.

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Appendix 1

Our information treatment consisted in providing the following eight points of information:

1) The malaria parasite is transmitted primarily at night, when someone is bitten by a female mosquito.

2) Malaria is the first cause of mortality in Senegal for pregnant women and children under 5 years.

3) Malaria is the main reason behind most medical consultations for Senegalese and therefore the main item for health care spending.

4) Our research in the city of Thies shows that households that use bednets are less affected by malaria and spend least for treatment. Households who use bednets regularly can make about 2000FCFA of savings per year in health care expenditures.

5) According to the Senegalese Ministry of Health and the World Health Organization: the best way to prevent malaria is to sleep under a bednet.

6) It is important to have mosquito bednets for all family members and use them throughout the year.

7) Long Lasting Insecticide Treated Nets are available in health centers and hospitals.

8) Mosquito nets are free for pregnant women and for children under five at health centers. For the rest of the population they are available at a subsidized price of 1,000 FCFA.

Figure 1. CONSORT flow diagram

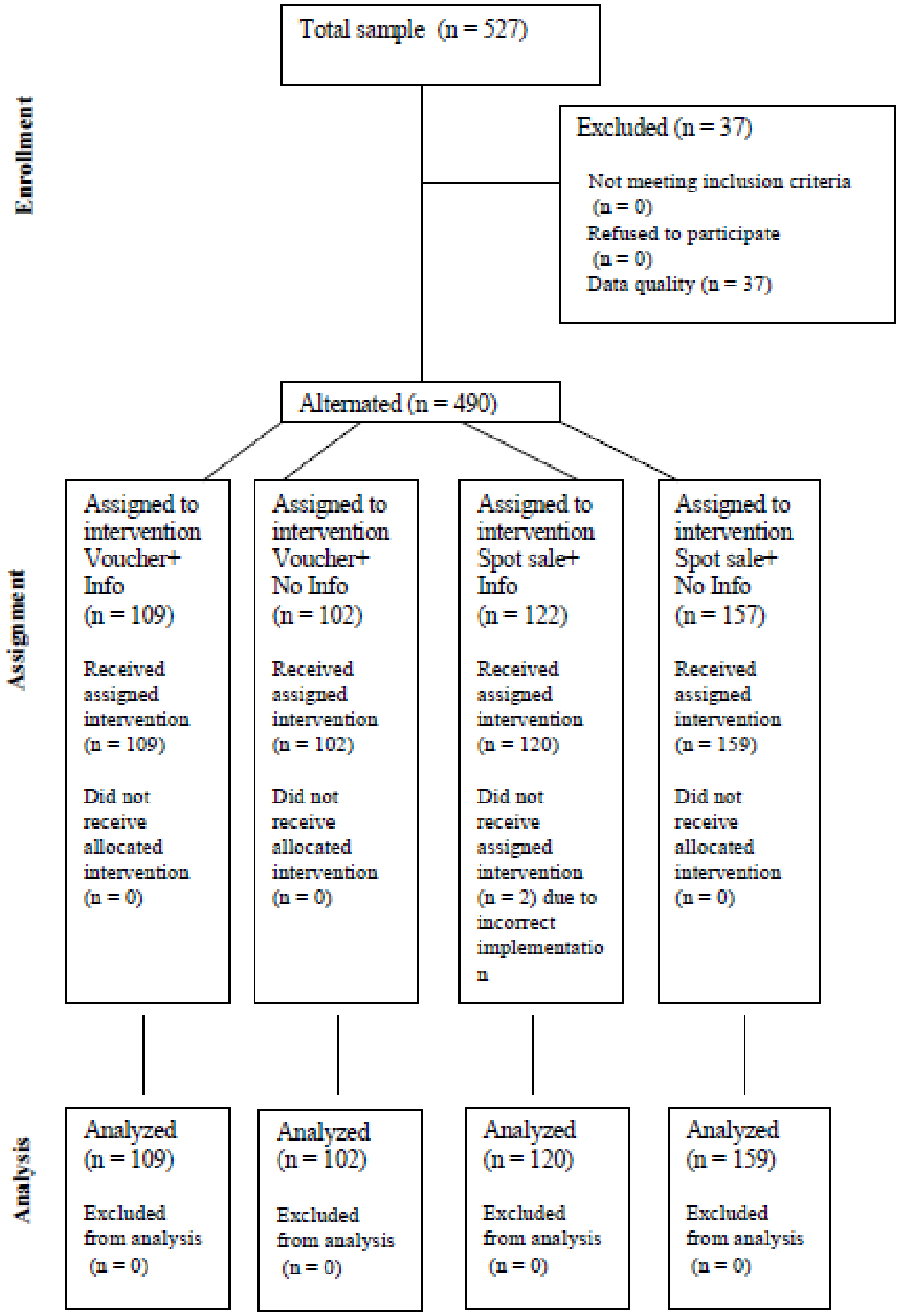
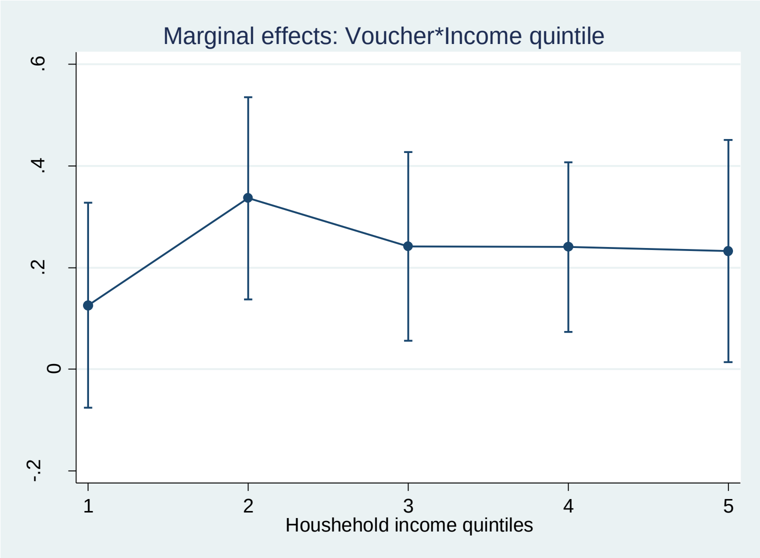
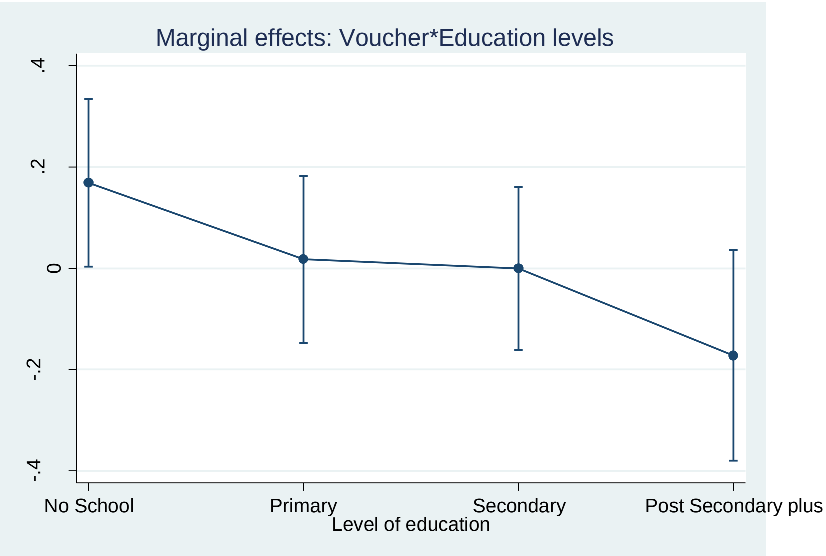


Figure 2. Contrast predictive margins for the coefficients Voucher*Income quintiles



Notes: 95% confidence interval, based on model 5 presented in table 4.

Figure 3. Contrast predictive margins for the coefficients Info*Education levels



Notes: 95% confidence interval, based on model 6 presented in table 4.

Table 1. Allocation across treatments and rate of household who bought LL-ITN by treatment

Treatment Sale	Treatment Information Yes	No	Total
Spot Sale	0.36	0.33	0.34
	(102)	(159)	(261)
Voucher	0.55	0.57	0.56
	(109)	(120)	(229)
Total	0.46	0.43	0.44
	(211)	(279)	(490)

Note: Fractions refer to the proportion of households who bought a LL-ITN; figures within brackets represent the size of each subsample, the total sample is 490.

Table 2. Mean, standard deviation, and comparisons of adjusted means of different treatment arms

			Balance of treatments tests							
			Information Treatment				Voucher Treatment			
	Mean	SD	Mean		Diff	P value	Mean		Diff	P value
			Treat	Control			Treat	Control		
The respondent is male	0.388	0.488	0.348	0.441	-0.094	0.035	0.397	0.379	0.018	0.688
Age of the respondent	44.559	13.527	44.086	45.185	-0.973	0.429	44.153	44.916	-0.794	0.515
The respondent is the head	0.488	0.500	0.444	0.545	-0.104	0.023	0.515	0.464	0.051	0.266
Respondent has no educ	0.288	0.453	0.330	0.232	0.095	0.019	0.262	0.310	-0.052	0.195
Respondent has primary educ	0.263	0.441	0.262	0.265	-0.007	0.869	0.279	0.249	0.031	0.436
Respondent has secondary educ	0.276	0.447	0.240	0.322	-0.079	0.050	0.306	0.249	0.060	0.135
Respondent has post-secondary educ	0.173	0.379	0.168	0.180	-0.008	0.806	0.153	0.192	-0.039	0.252
Household head is Male	0.880	0.326	0.871	0.891	-0.017	0.574	0.873	0.885	-0.010	0.721
The respondent lives in couple	0.900	0.300	0.903	0.896	0.007	0.785	0.900	0.900	-0.001	0.976
Household size	5.969	2.600	6.140	5.744	0.421	0.074	5.843	6.080	-0.243	0.298
Targeted hh during campaign	0.584	0.493	0.588	0.578	0.009	0.846	0.590	0.579	0.013	0.778
Income quintile 1	0.192	0.394	0.172	0.218	-0.050	0.155	0.192	0.192	-0.003	0.942
Income quintile 2	0.204	0.403	0.219	0.185	0.034	0.349	0.210	0.199	0.010	0.791
Income quintile 3	0.200	0.400	0.194	0.209	-0.015	0.684	0.197	0.203	-0.006	0.874
Income quintile 4	0.273	0.446	0.280	0.265	0.015	0.708	0.253	0.291	-0.035	0.384
Income quintile 5	0.131	0.337	0.136	0.123	0.016	0.611	0.148	0.115	0.034	0.273
Household owns dwelling unit	0.743	0.438	0.749	0.735	0.011	0.777	0.747	0.739	0.010	0.798
Assets (sum of items)	7.982	4.505	7.896	8.095	-0.105	0.790	7.694	8.234	-0.520	0.185
>1 episode of malaria previous year	0.463	0.499	0.444	0.488	-0.037	0.413	0.437	0.487	-0.046	0.298
No bednet in the hh	0.402	0.491	0.423	0.374	0.041	0.346	0.415	0.391	0.017	0.692
Malaria knowledge score, out of 5	3.606	1.026	3.509	3.735	-0.207	0.025	3.572	3.636	-0.055	0.545
Anti-Malaria campaigns knowledge score, out of 3	2.120	1.095	2.072	2.185	-0.089	0.348	2.114	2.126	-0.013	0.889

Notes: Diff is the adjusted difference of means between Treated and Control. P-val is the P-value of the treatment coefficients in a regression where baseline variables are regressed on the treatment variables and neighbourhood fixed effects. The shares of respondents in income quintiles 4 and 5 differ substantially from 20%. This is due to the fact that we have a disproportionate number of observations at a particular value (a midvalue of an income interval in the questionnaire) which cannot be split and is set to belong to quintile 4.

Table 3. Take-up of LL-ITN, main effects

	Dependent variable =1 if purchased LL-ITN			
	Unbalanced sample		Balanced sample	
	(1)	(2)	(3)	(4)
Treatment Sale (Voucher)	0.220***	0.239***	0.238***	0.238***
	(0.0442)	(0.0430)	(0.0446)	(0.0420)
Information session	-0.00270	0.0200	-0.0133	0.0164
	(0.0446)	(0.0437)	(0.0452)	(0.0435)
The respondent is male		0.000885		0.00751
		(0.0546)		(0.0538)
Age of the respondent		0.00189		0.00250
		(0.00210)		(0.00212)
Respondent has no education		-0.122		-0.116
		(0.0810)		(0.0798)
Respondent has primary education		-0.122		-0.116
		(0.0789)		(0.0771)
Respondent has Secondary education		0.0375		0.0484
		(0.0713)		(0.0708)
Respondent lives in couple		0.0431		0.0414
		(0.0776)		(0.0789)
Household size		0.00526		0.00913
		(0.00936)		(0.00956)
Targeted household during campaign		-0.0192		-0.0321
		(0.0504)		(0.0492)
Income quintile 1		0.185**		0.200**
		(0.0835)		(0.0819)
Income quintile 2		0.319***		0.336***
		(0.0812)		(0.0807)
Income quintile 3		0.218***		0.207***
		(0.0755)		(0.0731)
Income quintile 4		0.252***		0.268***
		(0.0694)		(0.0673)
Household owns the dwelling unit		-0.0845		-0.0705
		(0.0544)		(0.0539)
Assets (sum of items)		0.0103*		0.00887
		(0.00601)		(0.00628)
At least one episode of malaria previous year		0.0787*		0.0722
		(0.0444)		(0.0440)
No bednet in the hh		-0.0353		-0.0387
		(0.0473)		(0.0473)
Low malaria score (0-2)		-0.102*		-0.121**
		(0.0599)		(0.0585)
Low anti-malaria campaign score (0-1)		0.112**		0.114**
		(0.0482)		(0.0480)
Constant	0.303***	-0.117	0.263***	-0.137
	(0.0856)	(0.172)	(0.0704)	(0.173)
Observations	490	490	490	490
R-squared	0.074	0.160	0.080	0.173
Neighbourhood FE	Yes	Yes	Yes	Yes
Mean Dependent Variable	0.363	0.363	0.363	0.363

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. All specifications include neighbourhood fixed effects. The mean dependent variable refers to the take-up rate of the group which received on the spot sale and no information.

Table 4. Take-up of LL-ITN, heterogeneous effects

	Dependent variable =1 if purchased LL-ITN									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment Sale (Voucher)	0.236***	0.203***	0.268***	0.256***	0.232**	0.241***	0.241***	0.242***	0.283***	0.283**
	(0.0431)	(0.0680)	(0.0548)	(0.0541)	(0.111)	(0.0431)	(0.0430)	(0.0431)	(0.0558)	(0.131)
Information session (Info)	0.104	0.0211	0.0213	0.0208	0.0174	-0.174*	-0.00695	-0.0522	0.0193	-0.168
	(0.0683)	(0.0438)	(0.0439)	(0.0439)	(0.0440)	(0.105)	(0.0477)	(0.0550)	(0.0438)	(0.131)
Info*Targeted group	-0.144									-0.104
	(0.0914)									(0.0945)
Voucher*Targeted group		0.0612								0.0389
		(0.0888)								(0.0900)
Voucher*The respondent is male			-0.0744							-0.396
			(0.0923)							(0.347)
Voucher*Respondent is male*Respondent lives in couple				-0.0446						0.342
				(0.0912)						(0.340)
Voucher*Income quintile 1					-0.0959					-0.0879
					(0.154)					(0.155)
Voucher*Income quintile 2					0.0971					0.105
					(0.150)					(0.150)
Voucher*Income quintile 3					0.00946					-0.00938
					(0.146)					(0.146)
Voucher*Income quintile 4					0.0127					-0.0136
					(0.142)					(0.144)
Info*Respondent has no education						0.345***				0.280**
						(0.133)				(0.138)
Info*Respondent has primary education						0.196				0.161
						(0.135)				(0.138)
Info*Respondent has Secondary education						0.171				0.165
						(0.133)				(0.137)
Info*Low malaria score (0-2)							0.199*			0.137
							(0.117)			(0.120)
Info*No bednet in the household								0.180**		0.155*
								(0.0892)		(0.0911)
Voucher*No bednet in the household									-0.110	-0.0966
									(0.0913)	(0.0942)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	-0.158	-0.0956	-0.133	-0.128	-0.115	0.00287	-0.0932	-0.0570	-0.137	0.0117
	(0.184)	(0.182)	(0.182)	(0.183)	(0.185)	(0.192)	(0.182)	(0.182)	(0.182)	(0.203)
Observations	490	490	490	490	490	490	490	490	490	490
R-squared	0.164	0.161	0.161	0.160	0.163	0.172	0.164	0.167	0.162	0.191
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Neighbourhood FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dependent Variable	0.363	0.363	0.363	0.363	0.363	0.363	0.363	0.363	0.363	0.363

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include the set of controls as in table 3 and neighborhoods fixed effects. The mean dependent variable refers to the take-up rate of the group which received on the spot sale and no information.

Table 5. Rates of purchase across income quintiles for both the voucher and on-the-spot sale.

	on-the-spot sale			voucher				combined		
	n	mean	SE	n	mean	SE	P-value	n	mean	SE
income quintile 1	50	0.32	0.067	44	0.41	0.075	0.38	94	0.36	0.05
income quintile 2	52	0.35	0.067	48	0.67	0.069	0.001	100	0.5	0.05
income quintile 3	53	0.32	0.065	45	0.58	0.074	0.01	98	0.44	0.05
income quintile 4	76	0.41	0.057	58	0.66	0.063	0.004	134	0.51	0.043
income quintile 5	30	0.23	0.079	34	0.44	0.086	0.08	64	0.34	0.06

Notes: n is the sample size for each subsample; P-value is shown for a two-sided test of equality between the voucher and on-the-spot means.